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**Hydrographic Observations from
a Natural Marsh and a Marsh Altered by
Dredging, Bulkheading, and Filling
in West Bay, Texas**

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Hydrographic Observations from a Natural Marsh and a Marsh Altered by Dredging, Bulkheading, and Filling in West Bay, Texas¹

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ABSTRACT

Hydrographic data were collected from a natural marsh and a marsh altered by dredging, bulkheading, and filling in West Bay, Texas. Water samples were taken at 2-wk intervals during the day and night at 10 stations from 25 March to 21 October 1969. This report contains the location, depth, date, and time the samples were taken and corresponding measurements of water temperature, salinity, dissolved oxygen, dissolved organic nitrogen, nitrite, total phosphorus, inorganic phosphate-phosphorus, pH, carbon dioxide, total alkalinity, carbonate alkalinity, and turbidity.

INTRODUCTION

Numerous requests have been made in recent years by water resource planners pertaining to water quality conditions in estuarine areas altered by man. This report provides hydrographic data from a natural marsh and an area that was similar to the natural marsh prior to alteration by dredging, bulkheading, and filling. Some of these data have been reported in summary form by Corliss and Trent (1971), Moore and Trent (1971), Trent, Pullen, and Moore (1972), and Gilmore and Trent (1974).

STUDY AREA AND METHODS

The study area located in West Bay, Texas included a natural marsh area, an open bay area, and a canal area that was similar to the natural marsh before it was altered by channelization, bulkheading, and filling (Fig. 1). Ten sampling stations were established in the study area. Average water depths (mean low tide level) at Stations 1 through 10 were 1.6, 2.6, 2.2, 1.4, 1.3, 0.5, 0.2, 0.4, 0.5, and 1.0 m, respectively.

Samples of water were collected between 1000 and 1400 h and between 2200 and 0200 h at 2-wk intervals from 25 March to 21 October 1969 at each station. The samples were taken about 30 cm above the bottom with a triple bottle sampler (Texas A & M Univ., 1959).

Water samples were processed as follows. Water temperature was measured immediately after, and turbidity and pH were determined within 2 h after the samples were collected. Salinity, dissolved organic nitrogen, nitrite, total phosphorus, and inorganic phosphate-phosphorus samples were transferred into pyrex vials and alkalinity and carbon dioxide samples were stored in polyethylene containers. Chloroform (0.5 ml), mercuric chloride (0.2 mg), or carbon disulfide (0.5

ml) was added to the nutrient samples as a preservative and the samples were later filtered, quick-frozen, and stored for later analysis. Oxygen samples were collected in 300-ml biological oxygen demand bottles. Methods of chemical analyses employed and their precisions (when determined) are listed in Table 1, and the data are listed in Tables 2-13.

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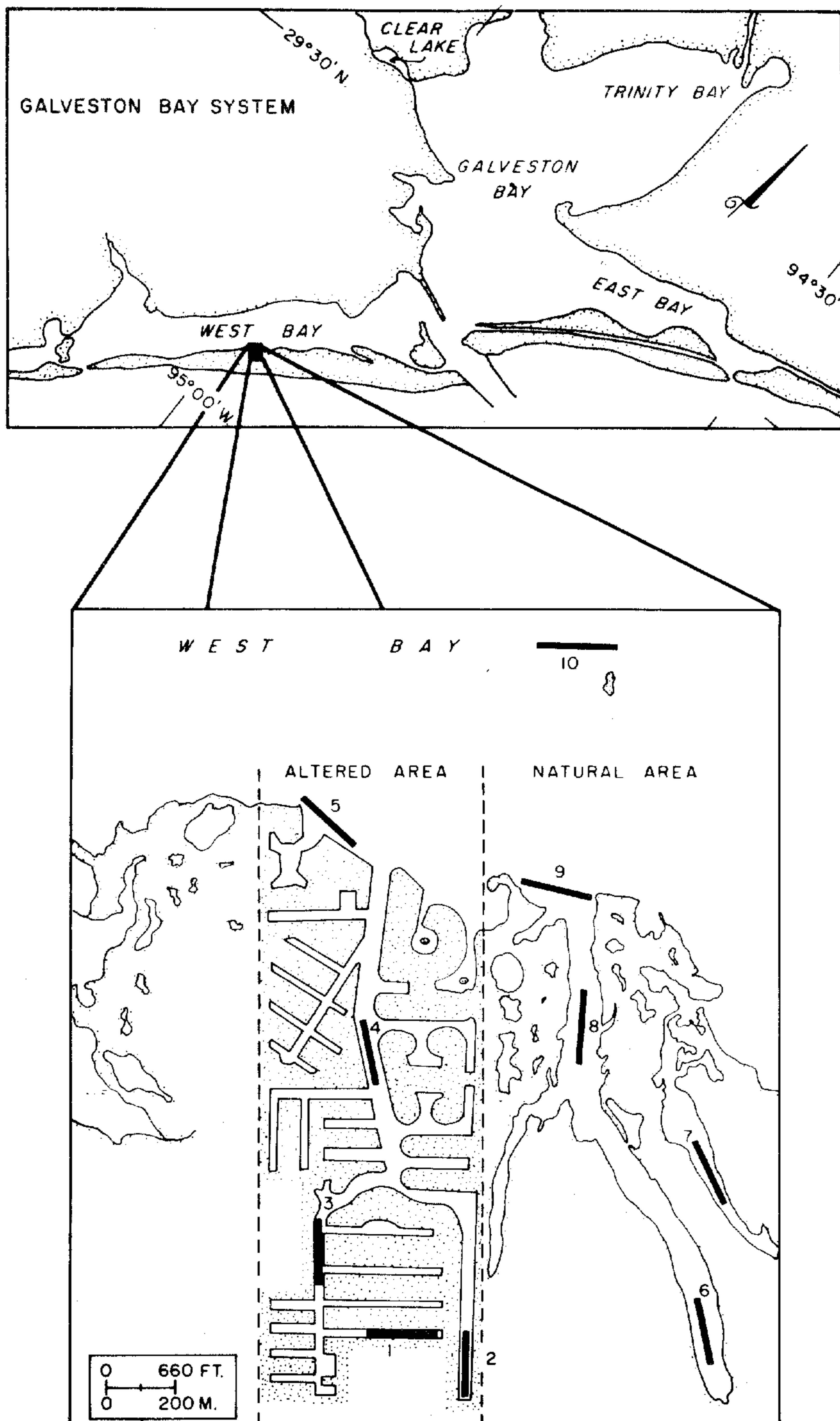


Figure 1.—Study area and sampling locations in the Jamaica Beach area of West Bay, Texas.

Table 1. References to analytical techniques, or types of equipment used, and the standard deviations of duplicate test results (when determined) expressed as a percentage of the means (coefficient of variation)

Hydrographic factor	Expressed in	Coef. of var.	Reference or type of equipment
Temperature	Celsius degrees ($^{\circ}$ C)	- <u>1/</u>	Mercury thermometer
Turbidity	Jackson turbidity units (JTU)	- <u>2/</u>	Hach turbidity meter
Salinity	Parts per thousand ($^{\circ}/oo$)	1.11	Marvin, et al. (1960)
Dissolved organic nitrogen	Microgram atoms per liter (ug atoms/liter)	10.61	"
Nitrite	"	6.73	Bendschneider and Robinson (1952)
Total phosphorus	"	4.90	Strickland and Parsons (1968)
Inorganic phosphate-phosphorus	"	4.43	"
Oxygen	Milliliters per liter (ml/liter)	2.63	Carritt and Carpenter (1966)
pH	pH units	-	Beckman meter
Carbon dioxide	Millimoles per liter (mmole/liter)	1.08	Strickland and Parsons (1968)
Total alkalinity	Milliequivalents per liter (meq/liter)	1.08	"
Carbonate alkalinity	"	1.08	"

1/ Not determined

2/ Reference to trade names does not imply endorsement by the National Marine Fisheries Service.

Table 2. Water temperature

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
°C											
Mar 25	Day	18.0	16.0	16.5	16.4	15.3	15.0	19.0	15.0	15.0	16.0
	Night	16.3	15.3	16.0	14.1	14.7	14.0	14.0	14.0	14.0	14.0
Apr 8	Day	23.7	23.1	23.6	23.5	23.0	23.0	23.0	23.0	23.0	23.0
	Night	23.3	22.4	23.1	23.2	23.8	23.0	23.0	23.0	23.0	23.0
Apr 22	Day	23.0	23.0	23.0	23.0	22.5	24.0	24.0	24.5	24.0	23.5
	Night	22.5	21.5	22.0	22.5	23.0	25.0	25.0	25.0	24.0	24.5
May 6	Day	24.0	23.8	23.5	23.0	23.0	23.0	23.0	23.0	23.0	23.5
	Night	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
May 20	Day	26.0	25.5	25.0	26.5	26.0	26.0	26.5	26.0	25.0	25.0
	Night	25.0	25.0	25.0	26.0	26.0	27.0	27.0	27.0	27.0	26.0
June 3	Day	27.0	26.0	26.0	25.0	25.5	24.0	24.5	25.5	26.0	25.5
	Night	26.0	25.0	25.5	25.0	24.5	25.0	24.5	25.0	24.5	25.0
June 17	Day	29.0	28.5	29.0	28.5	28.0	28.0	29.0	29.0	28.0	28.0
	Night	28.0	27.5	27.5	28.0	27.5	29.5	29.0	28.0	29.0	28.0
July 1	Day	31.0	30.5	31.0	31.0	31.0	30.5	31.0	31.0	31.0	30.5
	Night	30.5	30.0	31.0	30.0	31.0	31.0	31.0	31.0	31.0	31.0
July 15	Day	31.0	32.0	31.5	31.5	31.0	32.0	32.0	32.5	31.8	32.0
	Night	30.5	31.0	31.0	31.0	30.0	29.5	29.0	29.0	31.0	31.0
July 29	Day	31.0	31.0	31.0	30.5	30.0	29.0	30.0	31.0	31.0	30.0
	Night	31.0	30.0	30.0	30.5	30.0	30.0	29.5	30.0	30.0	30.0
Aug 12	Day	32.0	32.0	31.0	30.5	30.0	31.1	31.0	31.0	31.0	31.0
	Night	30.0	29.5	30.0	30.0	30.0	29.9	29.5	29.5	30.0	29.5
Aug 26	Day	31.5	30.5	31.0	31.0	29.5	30.7	30.0	30.0	30.0	30.0
	Night	29.5	29.0	30.0	30.0	29.5	29.6	29.0	28.5	28.0	28.0
Sept 9	Day	30.0	29.5	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
	Night	29.0	29.0	29.0	29.5	29.0	29.0	29.0	28.5	29.0	29.0
Sept 23	Day	28.5	28.0	28.5	28.5	29.0	27.2	29.0	28.0	28.0	29.0
	Night	28.0	27.0	28.0	28.0	27.5	27.5	26.0	27.2	26.0	29.0
Oct 7	Day	26.0	27.0	27.5	26.0	26.0	26.5	25.0	25.5	25.0	25.0
	Night	27.0	27.0	26.0	26.0	25.0	26.2	25.0	26.0	25.5	26.0
Oct 21	Day	25.0	25.0	25.0	26.0	25.0	26.0	26.0	26.0	25.0	26.0
	Night	26.0	26.0	26.0	24.0	24.5	23.0	23.0	23.0	24.0	24.0

Table 3. Salinity

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
°/oo											
Mar 25	Day	18.7	19.0	18.9	19.3	19.8	19.1	18.9	19.7	19.8	
	Night	18.7	19.1	19.0	19.2	20.0	19.9	19.8	19.9	20.1	
Apr 8	Day	19.7	20.0	19.9	20.3	20.7	20.5	20.9	20.5	20.2	
	Night	20.0	20.0	20.2	20.5	21.0	20.8	21.1	20.5	20.5	
Apr 22	Day	18.4	18.7	18.9	19.1	19.5	18.9	17.9	19.3	19.4	
	Night	18.8	18.9	19.0	19.2	18.6	19.1	18.7	19.4	19.5	
May 6	Day	19.0	19.3	18.8	17.2	17.0	18.9	18.7	17.4	17.3	
	Night	19.2	19.2	19.3	18.1	17.3	18.5	18.8	18.0	17.6	
May 20	Day	14.4	16.9	15.6	14.8	15.0	12.5	12.3	14.9	14.4	
	Night	14.8	14.8	15.3	14.8	14.7	13.0	10.7	13.9	14.8	
June 3	Day	15.3	16.1	14.7	15.0	15.4	13.7	12.2	15.1	15.5	
	Night	15.1	15.9	14.9	14.9	15.1	14.2	12.6	14.6	14.4	
June 17	Day	14.9	15.1	14.8	14.9	14.9	15.2	14.7	14.8	14.9	
	Night	14.8	14.9	14.9	15.0	14.9	15.5	15.4	14.9	15.0	
July 1	Day	27.6	27.4	27.5	27.8	27.9	27.3	27.1	27.1	27.0	
	Night	27.2	27.5	27.8	27.5	27.0	27.5	27.6	27.8	27.6	
July 15	Day	29.5	29.7	29.2	29.2	28.4	29.9	30.4	28.0	27.9	
	Night	29.7	29.6	29.5	29.0	28.4	30.0	28.1	28.0	28.1	
July 29	Day	29.2	29.5	29.8	30.4	31.4	29.6	30.0	30.5	30.7	
	Night	29.4	29.5	29.7	29.9	31.5	30.1	30.1	30.2	30.5	
Aug 12	Day	33.1	33.6	34.4	34.6	36.1	32.8	35.9	35.9	35.2	
	Night	34.1	34.2	34.7	35.5	35.9	35.7	35.9	35.9	35.9	
Aug 26	Day	34.8	34.9	34.7	34.7	33.9	33.7	33.7	34.2	34.2	
	Night	34.8	34.5	34.7	34.7	30.5	32.0	29.3	34.1	34.5	
Sept 9	Day	32.4	32.7	31.8	32.0	31.6	32.7	32.6	31.8	31.8	
	Night	32.4	32.5	32.5	32.4	31.6	32.6	32.9	32.7	32.5	
Sept 23	Day	30.0	29.9	29.5	28.3	26.5	28.4	32.2	29.5	26.7	
	Night	29.8	28.4	29.6	28.7	27.4	28.4	31.9	29.3	28.9	
Oct 7	Day	28.6	28.4	28.8	28.3	27.6	29.4	30.3	27.8	27.7	
	Night	29.0	28.6	27.4	28.4	28.2	29.5	30.9	29.3	29.0	
Oct 21	Day	28.8	28.4	28.6	27.7	27.0	28.8	29.3	27.4	26.9	
	Night	28.4	28.4	28.3	28.4	27.1	29.2	30.0	29.2	28.2	

Table 4. Dissolved oxygen

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----ml/liter-----											
Mar 25	Day	5.08	5.68	5.86	5.89	6.71	7.38	7.51	7.02	6.71	6.24
	Night	5.71	5.78	5.72	5.82	6.08	6.07	5.87	5.54	5.91	6.35
Apr 8	Day	4.59	4.78	3.67	4.12	4.42	4.67	4.29	4.38	4.19	5.19
	Night	3.74	4.19	4.81	5.03	4.85	5.04	4.12	4.57	4.34	5.08
Apr 22	Day	4.75	4.58	3.32	5.30	5.53	5.60	5.68	5.62	5.33	6.89
	Night	4.44	5.88	4.49	5.24	5.99	6.11	4.57	4.95	4.35	5.91
May 6	Day	4.05	4.23	4.51	5.04	5.13	5.26	4.30	4.69	5.16	5.28
	Night	4.32	3.79	4.79	4.88	4.90	5.29	4.69	4.28	4.78	5.34
May 20	Day	3.46	1.44	0.14	3.86	5.03	4.39	3.78	4.98	4.20	5.52
	Night	3.58	4.63	1.20	4.81	5.04	5.59	2.53	4.35	4.93	5.28
June 3	Day	1.75	0.08	3.47	4.49	4.75	4.10	3.92	4.47	4.50	5.12
	Night	3.61	0.65	2.80	4.79	4.58	5.26	3.15	3.75	4.60	5.67
June 17	Day	2.12	3.04	3.60	4.68	4.78	3.94	4.89	4.53	4.45	4.76
	Night	3.04	2.52	2.63	4.24	4.97	5.27	3.32	3.30	3.51	5.40
July 1	Day	1.88	1.07	3.39	3.52	3.37	3.69	3.28	3.83	3.48	3.14
	Night	0.58	0.37	2.71	2.07	1.76	4.86	4.14	3.03	3.97	3.36
July 15	Day	0.38	0.14	0.65	3.00	2.77	4.94	3.65	3.46	4.20	3.91
	Night	2.84	4.85	3.29	4.74	4.00	4.02	2.55	2.78	4.27	3.90
July 29	Day	1.67	1.65	0.21	3.76	3.78	3.40	3.68	3.44	4.05	4.02
	Night	5.03	0.14	1.78	4.67	3.44	4.79	1.50	3.48	2.53	2.99
Aug 12	Day	2.78	1.06	2.51	3.88	3.62	6.19	3.93	4.35	5.04	3.90
	Night	0.91	1.30	2.34	3.85	3.62	4.39	3.32	3.34	3.04	4.25
Aug 26	Day	3.21	2.92	3.41	3.02	3.53	4.44	4.32	4.88	4.79	3.95
	Night	2.80	2.84	3.57	4.32	4.34	4.72	3.01	2.65	2.53	4.26
Sept 9	Day	3.19	1.06	3.07	3.73	3.47	3.57	3.65	3.82	4.03	3.83
	Night	3.11	1.06	3.85	4.17	4.45	4.44	4.05	2.77	3.02	4.43
Sept 23	Day	2.56	2.77	2.31	3.65	3.07	3.32	2.33	2.20	4.02	4.94
	Night	3.73	0.37	2.31	3.90	3.36	3.94	3.27	1.61	2.28	4.53
Oct 7	Day	3.45	4.26	4.71	3.80	4.27	3.91	3.28	4.49	3.61	4.54
	Night	4.03	4.25	4.43	4.31	4.27	5.04	4.21	3.51	4.07	4.76
Oct 21	Day	2.82	4.28	2.61	4.23	4.27	4.48	3.25	4.17	4.34	5.18
	Night	4.63	4.69	4.90	4.73	5.10	4.92	3.10	3.70	4.67	4.98

Table 5. Dissolved organic nitrogen

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----ug atoms/liter-----											
Mar 25	Day	53	58	49	35	33	76	104	70	42	40
	Night	91	58	87	35	33	63	58	67	64	40
Apr 8	Day	34	43	53	51	69	58	54	43	46	43
	Night	52	59	52	37	46	63	60	57	56	54
Apr 22	Day	54	55	50	60	28	57	63	62	14	36
	Night	45	38	46	34	34	46	86	43	24	37
May 6	Day	110	105	80	96	105	105	63	82	87	84
	Night	118	84	123	84	84	86	82	67	74	79
May 20	Day	92	67	78	82	79	59	63	70	151	138
	Night	25	69	101	52	55	59	86	66	76	80
June 3	Day	73	73	61	71	54	70	68	52	67	57
	Night	100	67	74	83	71	106	99	54	59	47
June 17	Day	99	83	57	47	80	75	141	57	79	51
	Night	99	86	63	63	54	65	374	62	60	51
July 1	Day	48	50	84	22	21	32	53	39	60	38
	Night	80	30	27	21	19	25	31	29	27	36
July 15	Day	90	75	73	59	39	68	42	380	55	27
	Night	44	43	44	35	25	48	67	44	42	26
July 29	Day	38	23	33	27	34	35	43	27	21	26
	Night	27	28	42	24	28	33	34	28	30	35
Aug 12	Day	38	41	39	39	29	75	89	43	31	38
	Night	53	45	49	46	40	51	45	38	38	20
Aug 26	Day	42	44	38	63	44	41	49	30	29	32
	Night	27	56	45	38	35	47	41	26	28	31
Sept 9	Day	89	46	61	58	46	74	71	51	67	66
	Night	58	58	47	70	47	61	64	46	58	47
Sept 23	Day	64	96	54	63	102	130	118	68	98	97
	Night	84	87	61	69	102	54	55	82	78	67
Oct 7	Day	52	42	37	40	37	50	57	48	44	39
	Night	36	41	35	40	41	61	53	45	45	39
Oct 21	Day	52	36	43	39	34	36	45	32	33	47
	Night	49	44	52	48	41	41	47	42	46	38

Table 6. Nitrite

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----ug atoms/liter-----											
Mar 25	Day	0.10	0.00	0.00	0.10	0.00	0.00	1.10	0.00	0.00	0.10
	Night	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr 8	Day	0.00	0.20	0.00	0.70	0.00	1.10	0.40	0.10	0.10	0.00
	Night	0.00	0.10	0.10	0.00	0.00	1.10	0.00	0.20	0.00	0.20
Apr 22	Day	0.75	0.79	0.96	0.37	0.55	0.80	1.30	1.85	1.82	0.96
	Night	0.33	0.29	0.29	0.24	0.23	0.23	0.30	0.45	0.54	0.29
May 6	Day	0.33	0.35	0.47	1.30	1.71	0.42	0.45	1.34	1.17	2.49
	Night	0.44	0.35	0.47	0.85	1.66	0.51	0.41	0.59	1.05	1.62
May 20	Day	0.14	0.17	0.10	0.15	0.19	0.15	0.20	0.17	0.13	0.21
	Night	0.53	0.46	0.53	0.46	0.48	0.47	0.60	0.57	0.52	0.53
June 3	Day	0.02	0.08	0.04	0.05	0.18	0.10	0.14	0.17	0.15	0.13
	Night	0.59	0.64	0.64	0.55	0.59	0.53	0.69	0.57	0.56	0.50
June 17	Day	0.13	0.12	0.10	0.07	0.06	0.13	0.11	0.09	0.11	0.10
	Night	0.56	0.50	0.56	0.56	0.43	0.42	0.46	0.45	0.51	0.51
July 1	Day	0.36	0.15	0.15	0.15	0.16	0.19	0.47	0.16	0.19	0.20
	Night	0.22	0.27	0.21	0.27	0.25	0.24	0.23	0.24	0.25	0.25
July 15	Day	0.38	0.34	0.42	0.42	0.57	0.40	0.56	0.62	0.54	0.40
	Night	0.30	0.29	0.29	0.36	0.26	0.37	0.37	0.29	0.22	0.28
July 29	Day	0.38	0.37	0.39	0.44	0.45	0.44	0.37	0.30	0.16	0.51
	Night	0.45	0.40	0.48	0.42	0.43	0.45	0.45	0.52	0.16	0.52
Aug 12	Day	0.17	0.35	0.17	0.22	0.35	0.19	0.20	0.31	0.08	0.19
	Night	0.26	0.22	0.17	0.14	0.20	0.16	0.34	0.15	0.12	0.20
Aug 26	Day	0.22	0.27	0.39	0.42	0.49	0.30	0.52	0.45	0.39	0.42
	Night	0.56	0.60	0.58	0.67	0.66	0.62	0.45	0.52	0.77	0.59
Sept 9	Day	0.34	0.31	0.35	0.36	0.31	0.39	0.38	0.35	0.30	0.40
	Night	0.20	0.69	0.55	0.65	0.57	0.73	0.48	0.64	0.59	0.61
Sept 23	Day	0.35	0.27	0.37	0.30	0.31	0.43	0.47	0.51	0.41	0.29
	Night	0.35	0.28	0.24	0.34	0.32	0.37	0.41	0.35	0.37	0.36
Oct 7	Day	0.66	0.97	1.08	1.07	1.05	1.10	0.76	1.27	0.64	1.19
	Night	0.36	0.27	0.20	0.30	0.47	0.60	0.76	0.76	0.55	0.60
Oct 21	Day	0.36	0.30	0.29	0.39	0.45	0.29	0.47	0.30	0.36	0.21
	Night	0.22	0.22	0.22	0.31	0.84	1.07	1.28	0.49	0.16	1.31

Table 7. Total phosphorus

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----ug atoms/liter-----											
Mar 25	Day	5.8	8.0	6.0	8.7	8.0	9.3	8.2	9.0	6.6	11.4
	Night	5.0	8.0	5.5	6.0	6.1	6.9	4.7	5.2	6.0	6.6
Apr 8	Day	3.4	4.5	4.4	5.7	6.3	3.5	4.2	5.8	6.3	4.6
	Night	5.0	5.0	5.4	6.0	5.3	3.1	3.8	4.7	5.1	4.7
Apr 22	Day	3.2	4.0	4.9	4.1	3.1	2.8	3.5	4.1	3.7	4.7
	Night	4.0	3.9	4.8	3.9	4.4	3.2	3.5	4.2	4.0	4.4
May 6	Day	4.6	5.4	5.2	6.2	7.0	3.9	4.4	6.4	6.2	6.8
	Night	5.4	6.0	5.3	5.9	6.6	3.9	3.1	4.0	5.0	5.8
May 20	Day	5.0	8.4	8.5	5.5	5.4	3.9	4.1	5.1	2.6	3.7
	Night	6.9	3.9	7.7	4.4	3.7	4.3	3.2	3.7	4.1	4.2
June 3	Day	10.6	17.5	8.5	6.6	7.7	5.0	4.9	6.0	6.2	6.6
	Night	9.9	14.4	9.0	6.3	5.2	4.6	3.7	4.2	4.9	6.2
June 17	Day	6.9	9.0	7.8	6.4	8.1	5.0	7.1	7.6	8.7	7.9
	Night	11.1	10.7	10.0	9.0	8.5	5.5	4.3	5.7	6.1	8.5
July 1	Day	10.5	10.5	8.0	7.3	9.1	7.6	7.4	7.4	8.1	6.0
	Night	7.5	7.4	5.8	5.2	5.0	5.7	4.8	5.8	6.0	5.0
July 15	Day	10.5	8.2	7.5	5.9	5.8	8.7	7.5	5.8	4.3	7.5
	Night	7.3	6.4	7.3	5.9	5.3	7.6	6.6	6.6	5.2	5.5
July 29	Day	9.7	7.4	7.1	5.7	5.1	9.3	8.4	5.7	5.0	4.8
	Night	6.7	7.7	6.3	5.8	4.9	7.9	6.1	6.8	5.1	5.4
Aug 12	Day	9.2	7.6	7.0	7.0	4.4	11.8	8.5	6.1	4.1	4.6
	Night	8.9	8.5	8.9	6.5	6.6	10.9	10.5	7.3	6.7	4.2
Aug 26	Day	5.6	4.8	5.0	4.7	5.5	4.6	5.2	5.4	5.5	5.2
	Night	4.9	4.4	4.5	4.8	5.4	4.3	4.2	4.4	4.5	4.4
Sept 9	Day	5.9	5.2	5.8	6.0	6.8	6.7	6.5	7.0	6.6	6.7
	Night	5.2	6.0	6.0	5.3	6.4	6.5	5.7	6.0	5.9	7.1
Sept 23	Day	6.6	9.6	7.3	7.3	6.4	6.4	7.8	7.8	6.2	6.0
	Night	5.7	7.9	5.7	5.0	6.3	5.6	7.7	7.6	7.1	5.5
Oct 7	Day	3.2	4.0	4.0	4.9	5.9	4.5	4.4	4.0	4.4	5.0
	Night	3.0	4.5	3.8	4.6	5.4	4.8	4.6	4.5	5.3	5.7
Oct 21	Day	2.8	4.2	5.1	4.6	5.2	5.0	5.5	5.0	5.8	5.3
	Night	3.6	3.3	4.6	3.5	4.9	4.6	3.9	4.7	5.2	5.9

Table 8. Inorganic phosphate-phosphorus

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----ug atoms/liter-----											
Mar 25	Day	2.5	2.7	1.9	4.1	3.1	4.5	3.1	4.4	2.7	4.6
	Night	2.1	2.7	2.6	2.5	3.7	3.7	2.9	3.4	4.0	4.9
Apr 8	Day	3.4	4.8	4.3	5.4	5.4	3.8	4.2	6.2	5.2	4.8
	Night	5.0	5.4	5.3	5.1	5.5	3.4	3.9	6.2	5.2	4.9
Apr 22	Day	1.9	2.5	2.8	3.3	2.6	2.2	3.0	3.7	3.4	4.4
	Night	4.0	3.9	4.8	3.9	4.4	2.1	2.5	3.7	3.9	3.7
May 6	Day	3.1	3.1	3.7	5.0	5.2	2.7	2.7	4.8	4.7	5.2
	Night	3.0	2.6	3.9	3.9	5.4	2.6	2.1	2.8	3.9	4.4
May 20	Day	3.0	6.6	7.1	3.4	3.6	1.4	2.3	2.6	2.6	3.7
	Night	4.7	1.6	3.9	1.9	1.6	1.4	1.1	2.0	2.6	2.3
June 3	Day	8.0	13.5	6.2	4.8	5.6	3.4	3.2	4.2	4.1	4.5
	Night	8.2	12.2	7.8	5.5	4.3	3.0	2.3	3.5	3.4	4.6
June 17	Day	6.6	7.7	6.6	6.0	6.5	3.0	3.7	5.7	5.8	7.0
	Night	6.5	6.8	5.9	6.1	6.1	3.4	2.2	3.2	4.0	5.9
July 1	Day	4.4	3.9	2.9	2.8	3.4	3.0	2.7	3.0	3.0	3.1
	Night	5.6	4.6	4.4	4.0	4.3	4.0	3.5	4.1	4.4	4.0
July 15	Day	3.3	4.4	4.4	4.2	3.7	5.7	5.1	3.8	3.1	3.0
	Night	5.0	4.9	5.3	4.3	3.8	5.2	4.5	4.8	3.6	3.3
July 29	Day	6.1	5.1	4.5	3.6	3.5	6.4	5.8	4.0	3.6	3.1
	Night	4.5	4.9	4.3	4.0	3.7	6.2	4.9	5.3	4.0	4.0
Aug 12	Day	6.4	6.2	5.3	4.7	2.8	9.4	6.5	4.6	2.6	3.0
	Night	5.3	5.4	4.9	4.0	3.5	8.3	5.5	4.6	4.5	2.5
Aug 26	Day	4.3	3.6	3.8	3.7	4.4	3.2	3.8	4.0	4.2	4.6
	Night	3.6	3.6	3.3	3.4	4.3	2.6	2.6	3.0	3.5	4.4
Sept 9	Day	4.0	3.5	3.6	3.7	4.2	3.7	4.0	4.5	4.1	4.4
	Night	3.6	3.7	4.0	3.3	4.3	3.8	3.2	3.8	4.0	4.5
Sept 23	Day	3.3	3.4	3.8	3.7	4.0	3.6	3.2	3.9	3.3	2.8
	Night	3.9	4.6	3.4	2.6	3.2	2.9	3.2	3.6	3.1	3.4
Oct 7	Day	1.6	2.3	2.1	3.3	3.4	3.0	2.9	4.1	4.7	4.1
	Night	1.5	2.3	2.1	2.8	3.7	3.0	2.3	2.9	3.3	3.8
Oct 21	Day	1.3	2.1	3.3	2.8	3.6	2.6	2.9	3.3	3.5	3.7
	Night	1.7	2.0	2.6	2.1	2.4	2.5	2.0	3.0	3.2	3.9

Table 9. pH

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----units-----											
Mar 25	Day	8.0	8.1	8.0	8.0	7.8	7.4	8.1	8.0	8.0	7.9
	Night	8.2	8.1	7.9	8.0	7.8	8.1	7.9	7.7	7.9	7.9
Apr 8	Day	7.7	7.8	7.9	7.9	7.7	7.7	7.7	7.8	7.7	7.8
	Night	7.5	7.5	7.4	7.7	7.6	7.7	7.6	7.6	7.6	7.9
Apr 22	Day	7.9	7.9	7.6	7.9	8.1	7.9	7.9	7.9	8.1	8.1
	Night	7.9	8.1	7.9	8.1	8.1	8.1	8.1	8.0	7.9	8.2
May 6	Day	7.6	7.7	7.8	7.9	7.8	6.1	7.3	6.6	6.6	7.9
	Night	7.9	7.8	7.9	7.8	7.8	7.8	7.6	7.7	7.7	8.1
May 20	Day	7.6	7.4	7.9	8.3	8.6	7.7	8.0	8.4	8.5	8.8
	Night	7.7	7.8	7.5	7.9	8.0	8.0	7.5	7.7	8.0	8.2
June 3	Day	7.5	7.3	8.1	7.7	7.8	7.4	7.2	7.6	7.6	7.7
	Night	7.6	7.3	7.6	7.9	7.9	7.8	7.2	7.5	7.7	8.1
June 17	Day	7.6	7.6	7.8	8.0	8.0	7.5	7.6	7.8	7.8	8.0
	Night	7.7	7.7	7.7	7.8	8.0	7.8	7.6	7.5	7.6	8.0
July 1	Day	7.9	7.9	8.0	8.0	8.0	7.6	7.7	7.8	7.9	8.1
	Night	8.0	7.8	8.2	8.1	8.3	8.2	8.1	7.7	8.1	8.1
July 15	Day	7.9	7.7	7.4	8.1	8.2	8.2	8.1	8.1	8.0	8.1
	Night	8.2	8.5	8.4	8.4	8.3	8.4	8.3	8.2	8.3	8.3
July 29	Day	8.1	8.2	7.9	8.1	8.1	8.2	7.9	8.0	8.0	8.1
	Night	8.2	8.0	8.1	8.1	7.9	8.0	7.8	8.0	7.8	7.9
Aug 12	Day	7.8	7.7	7.9	8.1	8.2	8.2	8.1	8.2	8.3	8.2
	Night	7.8	7.9	8.1	8.0	8.1	8.0	8.2	8.0	8.0	8.2
Aug 26	Day	8.0	8.0	7.9	7.8	8.0	8.2	7.9	8.1	8.2	8.1
	Night	7.7	7.7	7.8	7.9	8.0	8.0	8.0	7.9	7.9	8.0
Sept 9	Day	7.9	7.8	7.8	8.2	8.2	7.6	7.5	7.7	7.7	7.0
	Night	7.7	7.8	7.8	7.9	8.0	8.0	7.9	7.8	7.8	8.1
Sept 23	Day	7.9	7.7	7.7	8.0	7.9	7.7	7.8	7.6	8.1	8.3
	Night	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.6	7.6	8.0
Oct 7	Day	7.8	7.8	7.9	8.0	8.0	8.0	7.6	7.9	7.7	8.0
	Night	7.9	7.9	8.0	8.0	8.0	8.1	7.9	7.6	7.6	7.9
Oct 21	Day	7.6	8.0	7.7	8.0	8.2	8.0	7.6	7.9	8.0	8.2
	Night	8.0	8.0	7.9	7.9	8.1	8.1	7.6	7.9	7.9	8.0

Table 10. Carbon dioxide

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----mmole/liter-----											
Mar 25	Day	2.25	2.05	2.20	1.95	1.64	2.09	2.00	1.93	1.85	1.65
	Night	2.28	1.99	2.20	2.12	1.92	2.07	2.04	1.93	1.95	2.04
Apr 8	Day	2.31	2.18	2.17	2.00	1.81	2.00	2.11	1.95	1.97	1.80
	Night	2.32	2.18	2.13	2.04	1.97	2.03	2.11	1.94	1.97	1.96
Apr 22	Day	1.93	1.72	1.84	1.69	1.42	1.54	1.75	1.48	1.42	1.33
	Night	1.77	1.62	1.66	1.56	1.38	1.45	1.56	1.41	1.45	1.32
May 6	Day	1.99	1.80	1.77	1.66	1.63	0.77	1.80	1.25	1.25	1.51
	Night	1.79	1.64	1.74	1.66	1.60	1.66	1.70	1.67	1.58	1.45
May 20	Day	1.67	1.83	1.78	1.13	1.08	1.18	1.11	0.94	1.08	1.03
	Night	1.70	1.31	1.72	1.39	1.25	1.24	1.36	1.31	1.23	1.22
June 3	Day	1.79	1.98	1.73	1.46	1.56	1.35	1.31	1.38	1.42	1.33
	Night	1.80	1.90	1.80	1.40	1.55	1.29	1.30	1.36	1.36	1.39
June 17	Day	1.83	1.80	1.68	1.45	1.45	1.70	1.57	1.46	1.50	1.52
	Night	1.85	1.72	1.67	1.59	1.47	1.59	1.95	1.64	1.54	1.38
July 1	Day	1.78	1.99	1.88	1.84	1.88	1.94	1.98	1.93	1.82	1.79
	Night	1.94	1.99	1.90	2.00	1.82	1.94	1.95	2.07	1.82	1.79
July 15	Day	2.21	2.16	2.28	2.02	2.02	1.96	1.96	1.81	1.80	1.85
	Night	2.02	1.65	1.94	1.72	1.71	1.72	1.97	1.73	1.73	1.74
July 29	Day	2.17	1.94	2.15	1.95	1.96	1.76	2.12	1.96	1.98	1.98
	Night	2.08	2.03	2.08	2.02	2.04	1.98	2.37	1.94	2.01	2.06
Aug 12	Day	2.26	2.26	2.15	2.04	2.03	1.96	2.13	2.00	2.09	2.21
	Night	2.21	2.17	2.12	2.01	2.00	2.07	2.24	2.09	2.09	1.99
Aug 26	Day	1.94	1.85	1.93	1.96	1.93	1.76	2.02	1.86	1.80	1.89
	Night	2.07	2.01	1.99	1.95	1.96	1.85	2.03	2.04	2.03	1.93
Sept 9	Day	1.81	1.80	1.86	1.85	1.82	2.20	2.32	2.09	2.06	2.34
	Night	2.01	1.86	1.95	1.92	2.09	2.19	2.49	2.27	2.21	1.92
Sept 23	Day	1.83	1.95	1.95	1.81	1.93	2.23	2.59	2.39	1.98	1.74
	Night	1.93	1.89	1.69	1.88	2.02	2.18	2.51	2.39	2.32	1.94
Oct 7	Day	2.67	2.67	2.63	2.59	2.59	2.61	2.79	2.66	2.72	2.59
	Night	2.62	2.62	2.59	2.59	2.59	2.58	2.66	2.78	2.78	2.63
Oct 21	Day	2.04	1.99	2.16	2.03	1.93	2.27	2.52	2.10	2.03	1.86
	Night	1.99	1.99	2.08	2.06	1.96	2.27	2.66	2.38	2.26	1.88

Table 11. Total alkalinity

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----meq/liter-----											
Mar 25	Day	2.39	2.21	2.37	2.07	1.69	2.05	2.14	1.98	1.96	1.72
	Night	2.49	2.16	2.28	2.25	1.98	2.26	2.14	1.98	2.05	2.14
Apr 8	Day	2.36	2.25	2.28	2.10	1.86	2.05	2.16	2.02	2.02	1.87
	Night	2.32	2.18	2.10	2.09	1.99	2.08	2.13	1.96	1.99	2.06
Apr 22	Day	2.03	1.81	1.86	1.78	1.57	1.63	1.84	1.57	1.57	1.47
	Night	1.86	1.78	1.75	1.72	1.53	1.60	1.72	1.53	1.53	1.50
May 6	Day	2.01	1.84	1.84	1.72	1.69	0.69	1.75	1.14	1.14	1.60
	Night	1.89	1.75	1.81	1.72	1.66	1.72	1.72	1.69	1.63	1.60
May 20	Day	1.63	1.80	1.87	1.35	1.44	1.22	1.22	1.17	1.33	1.49
	Night	1.75	1.37	1.72	1.46	1.37	1.36	1.37	1.35	1.35	1.37
June 3	Day	1.79	1.92	1.92	1.58	1.64	1.33	1.26	1.40	1.44	1.37
	Night	1.82	1.84	1.82	1.48	1.64	1.37	1.26	1.37	1.40	1.51
June 17	Day	1.87	1.84	1.79	1.58	1.58	1.70	1.61	1.54	1.58	1.67
	Night	1.92	1.79	1.73	1.67	1.61	1.70	1.99	1.64	1.58	1.54
July 1	Day	1.89	2.09	2.05	2.01	2.05	1.98	2.05	2.03	1.94	1.98
	Night	2.11	2.09	2.17	2.21	2.14	2.21	2.16	2.14	1.94	1.98
July 15	Day	2.34	2.23	2.26	2.23	2.30	2.17	2.23	2.01	1.96	2.05
	Night	2.30	2.09	2.37	2.11	2.01	2.11	2.30	1.98	2.03	2.05
July 29	Day	2.39	2.21	2.28	2.16	2.17	2.01	2.25	2.14	2.16	2.19
	Night	2.37	2.21	2.30	2.23	2.17	2.16	2.48	2.11	2.11	2.19
Aug 12	Day	2.40	2.37	2.35	2.33	2.39	2.31	2.43	2.36	2.33	2.21
	Night	2.35	2.28	2.31	2.30	2.36	2.31	2.63	2.33	2.33	2.35
Aug 26	Day	2.17	2.07	2.11	2.09	2.15	2.09	2.21	2.13	2.13	2.17
	Night	2.17	2.11	2.15	2.13	2.19	2.09	2.26	2.21	2.23	2.15
Sept 9	Day	1.96	1.91	1.98	2.14	2.11	2.25	2.34	2.17	2.14	2.21
	Night	2.09	1.98	2.07	2.07	2.28	2.39	2.67	2.40	2.34	2.17
Sept 23	Day	1.98	2.03	2.03	1.96	2.05	2.31	2.71	2.44	2.19	2.05
	Night	2.03	1.98	1.78	1.98	2.11	2.28	2.63	2.44	2.37	2.09
Oct 7	Day	2.78	2.78	2.78	2.78	2.78	2.80	2.81	2.78	2.78	2.78
	Night	2.73	2.73	2.73	2.73	2.78	2.74	2.77	2.78	2.78	2.74
Oct 21	Day	2.07	2.14	2.21	2.19	2.17	2.44	2.57	2.23	2.19	2.09
	Night	2.14	2.14	2.21	2.16	2.14	2.48	2.69	2.53	2.37	2.03

Table 12. Carbonate alkalinity

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
-----meq/liter-----											
Mar 25	Day	2.34	2.16	2.32	2.03	1.65	2.04	2.10	1.95	1.92	1.68
	Night	2.43	2.10	2.24	2.20	1.95	2.20	2.10	1.95	2.01	2.10
Apr 8	Day	2.33	2.22	2.24	2.06	1.83	2.02	2.13	1.99	1.99	1.84
	Night	2.30	2.16	2.09	2.06	1.97	2.05	2.11	1.94	1.97	2.02
Apr 22	Day	1.99	1.77	1.84	1.74	1.51	1.59	1.80	1.53	1.51	1.41
	Night	1.82	1.72	1.71	1.66	1.47	1.54	1.66	1.48	1.49	1.43
May 6	Day	1.99	1.82	1.81	1.69	1.66	0.67	1.75	1.14	1.14	1.56
	Night	1.85	1.71	1.78	1.69	1.63	1.69	1.70	1.67	1.60	1.54
May 20	Day	1.61	1.79	1.84	1.26	1.30	1.19	1.17	1.07	1.23	1.31
	Night	1.72	1.34	1.70	1.43	1.32	1.31	1.35	1.32	1.30	1.31
June 3	Day	1.77	1.92	1.86	1.55	1.61	1.32	1.26	1.38	1.42	1.34
	Night	1.80	1.84	1.80	1.44	1.60	1.33	1.26	1.35	1.37	1.46
June 17	Day	1.85	1.82	1.75	1.53	1.53	1.68	1.59	1.51	1.55	1.62
	Night	1.89	1.76	1.70	1.64	1.56	1.66	1.97	1.62	1.56	1.48
July 1	Day	1.85	2.05	2.00	1.96	2.00	1.96	2.02	1.99	1.90	1.92
	Night	2.06	2.05	2.09	2.15	2.05	2.13	2.10	2.11	1.91	1.92
July 15	Day	2.30	2.20	2.24	2.17	2.22	2.11	2.15	1.95	1.91	1.99
	Night	2.22	1.96	2.26	2.00	1.92	2.00	2.21	1.90	1.94	1.96
July 29	Day	2.33	2.13	2.24	2.10	2.11	1.93	2.21	2.09	2.11	2.13
	Night	2.29	2.16	2.24	2.17	2.13	2.11	2.44	2.06	2.07	2.15
Aug 12	Day	2.35	2.33	2.29	2.24	2.28	2.20	2.34	2.25	2.26	2.10
	Night	2.30	2.24	2.25	2.21	2.25	2.23	2.52	2.25	2.25	2.24
Aug 26	Day	2.09	1.99	2.05	2.04	2.07	1.98	2.15	2.04	2.02	2.08
	Night	2.13	2.07	2.09	2.07	2.11	2.01	2.18	2.15	2.16	2.08
Sept 9	Day	1.91	1.87	1.94	2.05	2.02	2.22	2.32	2.13	2.10	2.21
	Night	2.05	1.94	2.03	2.02	2.22	2.33	2.62	2.36	2.30	2.09
Sept 23	Day	1.93	1.99	1.99	1.91	2.01	2.28	2.67	2.41	2.13	1.96
	Night	1.99	1.95	1.74	1.94	2.08	2.25	2.59	2.42	2.34	2.04
Oct 7	Day	2.75	2.75	2.74	2.73	2.73	2.75	2.79	2.74	2.75	2.73
	Night	2.73	2.73	2.73	2.73	2.73	2.74	2.77	2.78	2.78	2.74
Oct 21	Day	2.04	2.09	2.18	2.14	2.10	2.39	2.55	2.19	2.14	2.02
	Night	2.09	2.09	2.17	2.12	2.08	2.41	2.66	2.48	2.33	1.98

Table 13. Turbidity

DATE	TIME OF DAY	STATION									
		1	2	3	4	5	6	7	8	9	10
		-----JTU-----									
Mar 25	Day	-	-	-	-	-	-	-	-	-	-
	Night	-	-	-	-	-	-	-	-	-	-
Apr 8	Day	-	-	-	-	-	-	-	-	-	-
	Night	-	-	-	-	-	-	-	-	-	-
Apr 22	Day	-	-	-	-	-	-	-	-	-	-
	Night	-	-	-	-	-	-	-	-	-	-
May 6	Day	6	9	8	13	11	12	8	10	12	13
	Night	11	14	15	12	23	13	11	8	11	18
May 20	Day	11	19	21	15	27	21	18	10	8	13
	Night	37	11	12	23	18	19	21	13	9	18
June 3	Day	38	36	50	38	96	42	23	23	22	23
	Night	19	18	33	33	58	14	11	11	10	43
June 17	Day	19	14	21	45	63	58	26	15	28	60
	Night	23	15	31	16	20	25	12	16	23	20
July 1	Day	27	32	27	36	98	22	22	23	24	46
	Night	15	23	18	24	34	32	20	18	18	26
July 15	Day	22	21	27	59	41	27	34	26	15	24
	Night	18	13	22	18	14	28	46	27	16	47
July 29	Day	17	14	21	16	31	25	24	21	17	27
	Night	12	33	18	30	28	16	56	23	9	23
Aug 12	Day	12	16	30	14	29	36	43	30	25	64
	Night	28	16	21	20	34	18	17	14	16	40
Aug 26	Day	11	11	22	18	28	47	20	13	14	15
	Night	11	6	9	16	23	19	16	13	10	19
Sept 9	Day	14	22	16	21	99	15	22	19	18	24
	Night	11	23	20	17	28	36	28	26	20	19
Sept 23	Day	13	15	11	14	20	25	21	19	18	18
	Night	9	15	10	17	23	17	17	16	18	24
Oct 7	Day	12	7	13	11	14	10	12	7	11	13
	Night	10	7	14	17	25	14	13	15	11	15
Oct 21	Day	14	8	12	10	12	12	12	12	9	13
	Night	8	9	11	18	22	18	14	14	13	16

- No data